Indian Institute of Technology, Delhi
EEL 101: Fundamentals of Electrical Engineering
Tutorial 6, 12th March, 2008

1. The complex power in a load is $1200\angle 25^o$ Volt-Amperes. Determine the apparent power (give units), the real power (give units), reactive power (give units) and power factor (leading, or lagging.)

2. The voltage across a load, and the current into a load are given by $\overline{V} = 120\sqrt{2}\angle 0^o$, and $\overline{I} = 10\sqrt{2}\angle 25^o$. Find the time average of the power delivered to the load. Find the peak instantaneous power delivered to the load. What is the apparent power delivered to the load?

3. A 460 Volt load draws 18 kVA at a lagging power factor of 0.82. Find the capacitance that is required to correct the power factor to 0.93, lagging. What is the reactive power (kVAR) consumed by the capacitor?

4. The voltage across a load, and the current into a load are given by $v(t) = 110\sqrt{2}\cos(120\pi t + 32^o)$ Volts, and $i(t) = 4.8\sqrt{2}\cos(120\pi t - 21^o)$ Amps. Find the complex power into the load. Graphically show the real, apparent, and reactive powers. Assuming that the load contains no energy storage, what is the peak value of the magnetic energy stored in the load? What value of capacitor connected across the load will make the power factor as seen by the source to be 0.92, lagging?

5. An electric motor is monitored with an ammeter, voltmeter, and wattmeter, which indicate 5.2 A, 120 V, and 480 W respectively. Assume 50 Hz operation. Draw a phasor diagram of the voltage and the current, assuming the voltage at zero phase and lagging current. What is the reactive power to the motor, including the units? To improve the power factor of the motor, a capacitor is hung directly across the motor terminals. What value of capacitance will give a unity power factor?

6. A load connected across a 200 V, 50 Hz line draws 10 kW at a leading pf of 0.55. Determine the current, and the reactive power. What series combination of circuit elements would be equivalent to such a load? What parallel combination of circuit elements would be equivalent to such a load?

7. Repeat the previous problem for a lagging power factor of 0.55.

8. The monthly rate schedule for IIT is as follows: For the first 5000 kWh at Rs. 12/kWh. The next 10000 kWh at Rs. 16/kWh, the next

50000 kWh at Rs. 20/kWh. Any excess beyond 50000 kWh is charged at Rs. 30/kWh. The total charge for energy is decreased or increased by 0.5% for each 1% that the average pf is greater or lesser than 85%. IIT consumes 200,000 kWh and 175,000 kVARh (lagging) per month.

(a) Compute the average monthly energy bill for IIT.

(b) Some professors of the EE department suggested that IIT should improve its power factor to 0.85, by installing capacitors. The capacitors would cost Rs. 50 per kVAR of reactive power to be consumed by the capacitors. Annual maintainance, depreciation etc. would cost about 25% of the amount invested for the capacitors. Estimate if such a proposal will reduce IIT's energy costs.